



An-Najah National University

Sugars and Sweeteners in Foods

By: Mohammed Sabah

- Our quality of life is highly dependent on our **taste sensory**.
- Since taste is the final **check** used to evaluate the **quality** of a food, and we select foods guided primarily by the emotions of **pleasure** or **displeasure** experienced upon tasting them.
- All **sugars** are carbohydrates and contain **four calories** per gram

- Sugars are forms of :
 - **monosaccharide**. Examples of monosaccharides are **glucose** (also called dextrose), **fructose**, and **galactose**.
 - When two monosaccharides combine, a **disaccharide** is formed. For example,
 - when **glucose** and **fructose** join together, the disaccharide **sucrose**, or table sugar, results.
 - **Maltose** is composed of **two glucose** molecules,
 - while **lactose** (milk sugar) is formed by one molecule of **glucose** and one molecule of **galactose**.

- When many sugar molecules are linked together, they form a **polysaccharide** (**poly** means “many”).
- **Polysaccharides are complex** carbohydrates.
For example:
 1. **starch,**
 2. **fiber,**

- To most people, “**sweet**” is **synonymous** with table **sugar (sucrose)**, which is derived from **sugarcane** or sugar **beets**
- Fructose is commonly referred to as “fruit sugar” because of its presence in **fruits**.

Reduced-calorie and low-calorie sweeteners

➤ Polyols

- Also called “sugar alcohols” or sugar replacers, polyols may be classified as:
- monosaccharide-derived:
 - sorbitol,
 - erythritol,
 - xylitol,
 - mannitol,

- disaccharide-derived:
 - maltitol,
 - isomalt,
 - lactitol,
- and polysaccharide-derived:
 - hydrogenated starch hydrolysates.

They are carbohydrates imparting a sweet sensation but are neither sugars nor alcohols

- Polyols are mostly reduced-calorie sweeteners and may be used as table sugar but are frequently used in conjunction with other sweeteners to achieve:
 - the desired sweetness level and taste.
 - With fewer calories than sucrose,

- they provide **sweetness** to:
 - sugarfree cookies,
 - candies,
 - chewing gum,
 - baked goods,
 - ice cream,
 - toothpastes,
 - mouthwashes,
 - and pharmaceuticals.

Benefits of Polyols:

- help retain moisture in foods,
- do not lose sweetness,
- and do not cause browning when heated.
- molds do not grow well on polyols, they may contribute to longer shelf life of foods.

- for commercial uses they are made from some carbohydrates, such as
 - starch,
 - sucrose,
 - and glucose.

The FDA considers the sugar alcohols listed before as either generally recognized as safe (**GRAS**) or **approved** food additives.

❑ **Generally recognized as safe (GRAS)** is an American Food and Drug Administration (FDA) designation that a chemical or substance added to food is considered safe

Health Characteristics of polyols in the body:

- Polyols are incompletely absorbed from the small intestine into the bloodstream, producing a lower glycemic response (i.e., a lesser effect on blood glucose) than sucrose or glucose.

In theory, polyols may be useful to diabetics,

- Unabsorbed polyols continue to the large intestine, where they are fermented by bacteria.

Some individuals who consume excessive amounts of polyols may experience gastrointestinal symptoms, such as gas and laxative effects, similar to reactions to high-fiber foods and beans .

- The American Dietetic Association advises that consuming more than 50 grams per day of sorbitol or 20 grams per day of mannitol may cause diarrhea.

In such cases, the amount consumed on a single occasion should be reduced.

- Consequently, labels of polyol-containing products must bear the statement, “Excess consumption may have a laxative effect.”

- Polyols are also non-cariogenic—they do not promote tooth decay

because bacteria in the mouth do not metabolize and convert the sweetener harmful acids that cause tooth decay.

- The U.S. Food and Drug Administration (FDA) authorizes the use of this claim on labels of products containing sugar alcohols.

- The name of the polyol used in a product is listed in the ingredient list.
- The term “sugar alcohol” must be used if more than one polyol is used.
- If the terms “sugarfree” or “no added sugar” are used, the sugar alcohol content must be declared separately under carbohydrates in the Nutrition Facts panel.

Trehalose

- Trehalose is a disaccharide consisting of two glucose molecules. It is half as sweet as sucrose, provides continual energy, and elicits a very low insulin response.

It is found in common foods such as:

- honey,
- mushrooms,
- and shrimp
- and is naturally produced by the body.

Trehalose may be used in foods and beverages
such as:

- fruit juices,
- white chocolate,
- and dehydrated fruits and vegetables.

- **Trehalose characteristics in food:**

- It is heat stable,
- and in addition to being a sugar, it also stabilizes proteins, or prevents protein aggregation.
- Trehalose protects and preserves cell structure in foods and may be useful in freezing and thawing processes by maintaining a desired texture.

- The FDA has given trehalose a GRAS designation.
- It is approved for use in Japan, Taiwan, and Korea, and it is used in the frozen products in the United Kingdom.
- Trehalose is commercially prepared from starch.

Tagatose

- is a low-carbohydrate sweetener contributing 1.5 calories per gram, and it is especially suitable as a flavor enhancer at low doses,
- it is a white, crystalline powder that is prepared from lactose.
- It was first launched in the United States in May 2003 with FDA notification as a GRAS ingredient.

- Its safety was confirmed by the Joint FAO/WHO Committee on Food Additives (JECFA) in June 2004 with no limited acceptable daily intake (ADI),
- Tagatose is ideal for use in diet soft drinks because of its synergistic effect when used in combination with other sweeteners such as:
 - acesulfame-K,
 - sucralose,
 - and aspartame.

Tagatose characteristics in foods:

- Sweetness onset occurs rapidly, and bitterness is reduced.
- Enhance mint and lemon flavors in chewing gums, and toffee flavor,
- and enhance creaminess in some dairy product applications.
- It is pH-stable in acidic products, such as carbonated beverages and yogurts.
- but it caramelizes or browns more readily than sucrose.

- **Characteristics of Tagatose in the body:**
 1. only **15–20** percent of tagatose is absorbed in the small intestine.
 2. Due to incomplete absorption, tagatose has **minimal effect on blood glucose and insulin levels.**

3. The rest of the ingested tagatose proceeds to the **large intestine**



where it acts as a *prebiotic*, promoting the production of **butyrate** bacteria (considered “good” bacteria),



which are **essential** in maintaining a healthy **digestive** system (including enhancing **mineral** absorption)

4. tagatose is fermented in the colon to short-chain fatty acids that decrease acidity and may contribute to a healthy epithelium in the large intestine.
5. This fermentation, however, may result in mild gastrointestinal discomfort (e.g., flatulence and laxation) in some sensitive individuals, just as high-fiber carbohydrates do.
6. Tagatose is also non-cariogenic.

Acesulfame potassium

- Also known as acesulfame-K, is a high-intensity, non-nutritive sweetener that is 200 times sweeter than sucrose.

It has the following Characteristics :

- imparts a clean, sweet taste with no lingering after taste.
- It is non-cariogenic,
- is stable under high temperatures,
- and has an excellent shelf life.
- It is not metabolized or stored in the body, being quickly absorbed and then excreted unchanged.

It is used as a sweetener in many **foods, including:**

- chewing gums,
- baked goods,
- dessert
- and dairy products,
- alcoholic beverages,
- canned foods,
- and candies

- The FDA first granted the use of acesulfame potassium in soft drinks in July 1988 
- and has since reaffirmed its safety on several occasions until granting its general-use approval in December 2003 with no restrictions for any segment of the population, including pregnant women and diabetics.
- Use of acesulfame potassium does not require a warning label or information statement.
- It has been used in Europe since 1983, JECFA has also found it safe.

- JECFA set an acceptable daily intake (ADI) of 15 mg/kg body weight as the amount of this ingredient a person can safely consume each day for an entire lifetime.
- Because acesulfame potassium is a high-intensity sweetener that is used in very small amounts, even if it were the only low-calorie sweetener used today, the daily intake by a heavy food and beverage consumer would not exceed 3.8 mg/kg body weight, which is much lower than the ADI of 15 mg/kg body weight.

- The results of several long-term animal studies using much higher amounts of acesulfame potassium than are normally consumed by humans indicated no evidence of cancers or tumors.
- There is also no evidence of potential health concern from the 10 mg of potassium in a packet of acesulfame potassium table-sweetener.

For comparison, a banana may contain 400 mg potassium and a sweet potato 390 mg.

- In addition, there have been no documented cases of allergic reactions to acesulfame potassium.

Aspartame E951.

- Aspartame is a nutritive sweetener containing 4 calories per gram.
- it is **200 times sweeter than sucrose**, however, very little aspartame is needed to impart the same sweetness as sugar, resulting in minimal calories added to foods.

- Aspartame **completely breaks down** upon digestion into:
 1. methanol
 2. the amino acids aspartic acid
 3. and phenylalanine.
- These components are then **absorbed** into the blood and **used** by the body in exactly the same ways as when they come from other foods and beverages.

Characteristics of Aspartame:

1. Aspartame has a **clean, sugar-like** taste,
2. enhances fruit and citrus flavors,
3. can be **safely** used under **heat** with some **loss** of sweetness at higher temperatures,
4. and is **non-cariogenic**.
5. it is helpful to **diabetics**
6. and beneficial in **weight control** by managing caloric intake while still maintaining a healthful diet.

- today is an important component of thousands of foods and beverages.
- The FDA approved aspartame first in 1981 for use in table low-calorie sweeteners and powdered mixes
- and later in for carbonated beverages.
- It was given approval for use in all foods and beverages in 1996

- The FDA continues to confirm its safe use **by the general public, including**:
- diabetics,
- pregnant
- and nursing women,
- and children.

- People with a rare hereditary disease known as **phenylketonuria** (PKU) must control their **phenylalanine** intake from all sources, including **aspartame**.
- Products sweetened with aspartame must **carry** a statement on the label that they contain phenylalanine.

- Aspartame is used in more than **100** countries including Canada, Japan, the UK, and Germany.
- It is found in more than **6,000 products**
- and is estimated to be consumed by more than **200 million** people worldwide.

- In the United States, **health organizations** such
as:

1. the American **Medical** Association,
2. the American **Dietetic** Association,
3. and the American **Diabetes** Association

All these organizations have reviewed **research** on aspartame and also concluded **that it is safe**.

- **JEFCA** has also found aspartame **safe** for food use.
- The Acceptable Daily Intake (**ADI**) value for aspartame was set at **40** mg/kg body weight according to JECFA.

- Results of **extensive** market research studies indicate that **9 out of 10** people consume **less than 10 percent of the ADI**.
- Aspartame is available under the **brand names**:
 - ✓ Nutrasweet,
 - ✓ Equal,
 - ✓ Spoonful
 - ✓ and Equal-Measure.
- Aspartame has had its share of **allegations** and **unfounded** claims, including being linked to tumors, cancer, epilepsy, headaches, and weight increase.

Neotame E961

- This is a non caloric sweetener consisting of two amino acids, aspartic acid and phenylalanine.

Neotame has the following characteristics:

- ❖ It has a clean, sugar-like taste
- ❖ and is non-cariogenic.

- ❖ It is **30–40** times sweeter than aspartame,
- ❖ Through **normal** biological processes, has the following route:
 - ✓ neotame is quickly metabolized,
 - ✓ fully eliminated,
 - ✓ and does not accumulate in the body.
- ❖ No special labeling for **PKU** is required.

- Neotame is used in **many applications**; It is found in:
 - ✓ cooking and baking applications,
 - ✓ chewing gums,
 - ✓ carbonated soft drinks,
 - ✓ frozen desserts and novelties,
 - ✓ yogurt-type products,
 - ✓ refrigerated and non-refrigerated ready-to-drink beverages,
 - ✓ and puddings.

- Neotame has the following **properties and benefits** in food applications:
 - ✓ An excellent flavor-enhancer,
 - ✓ It prolongs flavor and sweetness in chewing gum
 - ✓ and masks flavors unique to soy-based, nutritionally fortified products, vitamins and minerals.

- Possible **benefits** of these properties are:
 - ✓ cost reduction
 - ✓ and better sensory acceptance qualities

- In July **2002** the **FDA** allowed its use as a general purpose sweetener for the general population, including:
 - ✓ pregnant
 - ✓ nursing women,
 - ✓ diabetics,
 - ✓ and children.

Saccharin E954

- Saccharin has been in use for over a **century** to sweeten foods and beverages without adding calories or carbohydrates.
- It was especially useful in **Europe** during the two world wars, when sugar was in short supply.
- It has been an integral component of the lifestyle of many people for: **weight control** and **caloric or carbohydrate** intake restriction.
- Like most other low-caloric sweeteners, saccharin helps **prevent the formation of dental cavities**, compared to sugar.

- In 1977, FDA proposed a ban on saccharin based on studies that linked its use to **bladder cancer**.
- Research methodologies involved the use of a **sensitive strain** of laboratory **rats** fed with extremely high doses of saccharin.
- Although the United States Congress overrode the ban because of the need at that time for a low-calorie alternative to sucrose,
So a **warning label** was required on products containing saccharin.

- In May 2000, due to a **predominance** of scientific results obtained from nearly **20 years of studies**, the government removed saccharin from its list of substances reasonably anticipated to be human carcinogens.
 - The federal requirement for a warning **label** on products containing saccharin **has also been removed**.
- Saccharin is not metabolized by the body
- and does not react with DNA,
- So lacking two of the major characteristics of a **classical carcinogen**.

- Saccharin continues to be used in a wide range of foods and beverages. It is found in:
 1. soft drinks,
 2. baked goods,
 3. chewing gum,
 4. canned fruit,
 5. salad dressings,
- ✓ and also in cosmetic products and pharmaceuticals.

- It is approved for use in more than **100** countries. Its safety has been affirmed by **JEFCA with (ADI)** equal to **5 mg/kg** of body weight.
- Its use is also supported by many health organizations including the American **Diabetes** Association, the American **Medical** Association, and the American **Cancer** Society.

Sucralose

- The only non-caloric sweetener prepared from sucrose,
- sucralose is manufactured through a **patented multi-step process** that replaces three **hydroxyl** groups of the sucrose molecule with three **chloride** groups.
- These **tightly bound chloride** groups make sucralose exceptionally **stable** and **indigestible**, which makes sucralose **free** of dietary **calories**.

- **Sucralose characteristics:**

1. Sucralose is a sweetener that is **600 times** sweeter than sugar
2. Has a **clean, sugar-like** taste and **no lingering** aftertaste.
3. It can be used **anywhere sugar is used** without losing its sugar-taste properties even when **heated** and **stored** for a long time.
4. Thus it is now used as a spoonful-for-spoonful replacement for sugar in:
 - ✓ eating,
 - ✓ baking,
 - ✓ cooking, and other sugar applications.

- In **1999** the FDA allowed its use as a general purpose sweetener for the **general population**, including: pregnant or breastfeeding women, children, and diabetics.
- It is now used in more than **3,500** products in over **60** countries, including Canada, Australia, and Mexico.

- Sucralose health benefits:
 1. Like the other low-calorie sweeteners, sucralose **passes quickly** through the body relatively **unchanged**.
 2. It is **not recognized** by the body as either a sugar or a carbohydrate.
 3. Sucralose is also **non-cariogenic** because it is an inert ingredient that cannot be acted upon by bacteria in the mouth.

- It is **stable** over a wide range of temperatures over time, and it is used in many **applications** such as:
 - ✓ canned fruit,
 - ✓ low-calorie beverages,
 - ✓ baked goods,
 - ✓ nutritional supplements,
 - ✓ and medical foods.

- Sucralose joins the other food ingredients that have been **extensively studied**.

More than **100 scientific studies** over a 20-year period were conducted to assess its safety **regarding** cancer, reproduction and fertility, genetic effects, birth defects, immunology, the central nervous system, and metabolism.

- Findings of scientific standards has indicated that sucralose **does not cause:**
 - cancer,
 - genetic defects,
 - birth defects,
 - or tooth decay.
 - In addition, sucralose has no effect on the immune system,
 - female or male reproduction,
 - blood glucose levels,
 - insulin production,
 - and carbohydrate metabolism.

- The **added chloride** is a natural component of many everyday foods and beverages, such as natural **waters**, **lettuce**, and **tomatoes**, and is safe.
- The safety of sucralose is confirmed by JECFA with **ADI** equal to **15 mg/kg** body weight per day.
- Products containing sucralose **are not required** to carry a warning **label**.
- Sucralose is currently marketed under the name **Splenda**.